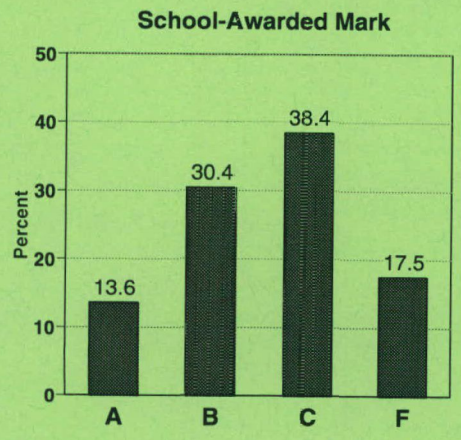
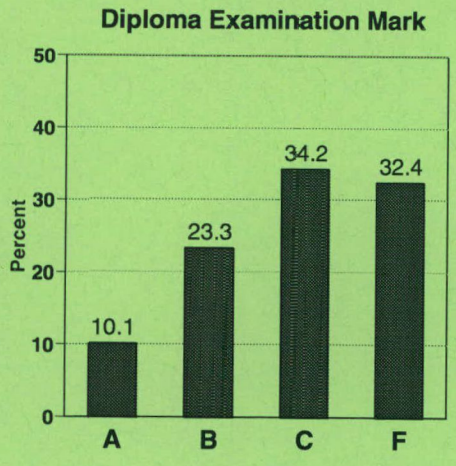
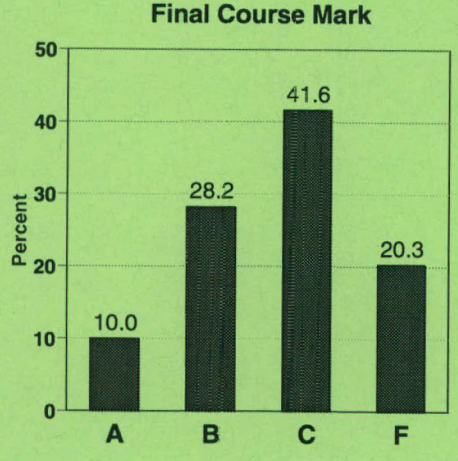
Mathematics 33

Diploma Examination Results
Examiners' Report for June 1998







The summary information in this report provides teachers, school administrators, and students with an overview of results from the June 1998 administration of the Mathematics 33 Diploma Examination. This information is most helpful when used with the detailed school and jurisdiction reports that are provided electronically to schools and school jurisdiction offices. A provincial report containing a detailed analysis of the combined November, January, June, and August results is made available annually.

Description of the Examination

The Mathematics 33 Diploma Examination consists of 37 multiple-choice questions worth 53%, 12 numerical-response questions worth 17%, and 4 written-response questions worth 30% of the total examination.

Achievement of Standards

The information reported is based on the final course marks achieved by 5 818 students who wrote the June 1998 examination.

- 79.7% of the 5 818 students achieved the acceptable standard (a final course mark of 50% or higher).
- 10.0% of the students achieved the standard of excellence (a final course mark of 80% or higher).

Overall, student achievement in Mathematics 33 was satisfactory. However, the percentage of students who achieved the acceptable standard (79.7%) was significantly less than the percentage for June 1997 (85.0%). Most students demonstrated a good ability when interpreting graphs and tables that represented various functions and relations. Students were also successful when answering questions involving statistical and financial concepts using information from their data booklet. Some students had difficulty with concepts related to quadratic functions and with procedures involving multiple right triangles.

Approximately 51.4% of the students who wrote the examination were female. Of these, about 80.0% achieved the acceptable standard for a final course mark, compared with 79.4% of the male students. Approximately 10.8% of the female students achieved the standard of excellence for a final course mark, compared with 9.1% of male students.

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Provincial Averages

- The average school-awarded mark was 61.9%.
- The average diploma examination mark was 57.2%.
- The average final course mark, representing an equal weighting of the school-awarded mark and the diploma examination mark, was 60.0%.

Of the 5 818 students who wrote the January 1998 examination and received a school-awarded mark, 334 had written at least one other Mathematics 33 Diploma Examination during the June 1997 to June 1998 period.

Results and Examiners' Comments

This examination has a balance of question types and difficulties. It was designed so that students who are achieving the acceptable standard should obtain a mark of 50% or higher and students achieving the standard of excellence should obtain a mark of 80% or higher.

In the following table, diploma examination questions are classified by question type: multiple choice (MC), numerical response (NR), and written response (WR). The column labelled "Key" indicates the correct response for multiple-choice and numerical-response questions. For numerical-response questions, a limited range of answers was accepted as being equivalent to the correct answer. For multiple-choice and numerical-response questions, the "Difficulty" indicates the proportion (out of 1) of students answering the question correctly. For written-response questions, the "Difficulty" is the mean score (out of 1) achieved by students who wrote the examination.

Questions are also classified by course unit topic and mathematical understanding. The abbreviations for these areas are expanded in results that follow the table.

Blueprint

Question	Key	Difficulty	RF	Q	PR	RE	TR	ST	AML	Math Und.
MC1	B	0.820							✔	P
MC2	C	0.693					✔			PS
MC3	C	0.565	✔							PS
MC4	D	0.618	✔							C
MC5	B	0.774						✔		C
MC6	D	0.632						✔		PS
NR1	95.6	0.432			✔					P
MC7	C	0.891							✔	C
WR1	–	0.559							✔	P/C/PS
MC8	B	0.440							✔	C
MC9	D	0.584		✔						PS
MC10	B	0.645							✔	PS
NR2	21	0.822	✔							P
NR3	79.2	0.714				✔				P
WR2	–	0.405					✔			P/C/PS
MC11	B	0.810					✔			PS
MC12	D	0.576		✔						C
MC13	A	0.697					✔			C
MC14	A	0.628	✔							C
MC15	D	0.628					✔			P
MC16	D	0.720				✔				C
NR4	15	0.506				✔				P
MC17	A	0.580				✔				P
MC18	C	0.585				✔				P
NR5	11	0.698			✔					P
MC19	A	0.788			✔					P
MC20	A	0.586			✔					P
MC21	C	0.384			✔					P
NR6	16.2	0.568			✔					P
MC22	D	0.304	✔							C

Question	Key	Difficulty	RF	Q	PR	RE	TR	ST	AML	Math Und.
NR7	29.4	0.645	✔							C
MC23	B	0.511		✔						C
MC24	C	0.700		✔						P
MC25	A	0.603		✔						C
NR8	80.5	0.754	✔							P
WR3	–	0.359		✔						P/C/PS
MC26	B	0.702		✔						C
NR9	136	0.579		✔						P
WR4	–	0.590	✔							P/C/PS
MC27	D	0.758						✔		C
MC28	C	0.674						✔		C
MC29	D	0.701						✔		P
MC30	C	0.553					✔			P
NR10	264	0.731					✔			P
NR11	2175	0.299							✔	P
MC31	A	0.481						✔		C
MC32	B	0.779		✔						C
MC33	C	0.313		✔						PS
MC34	A	0.622					✔			PS
MC35	B	0.573					✔			P
NR12	285	0.248					✔			PS
MC36	C	0.528				✔				C
MC37	A	0.615	✔							PS

Subtests: Machine Scored and Written Response (Average by Subtest)

When analyzing detailed results, please bear in mind that subtest results **cannot** be directly compared. Results are in average raw scores.

Machine scored: 30.1 out of 49

Multiple choice: 23.0 out of 37

Numerical response: 7.0 out of 12

Written response: 9.9 out of 21

Raw Score Average for Machine-Scored Questions by Course Unit

RF	Relations and Functions	5.0	out of	8
Q	Quadratic Functions and Equations	5.3	out of	9
PR	Powers and Radicals	3.5	out of	6
RE	Polynomials and Rational Expressions	3.6	out of	6
TR	Trigonometry	5.6	out of	9
ST	Statistics	4.0	out of	6
AML	Annuities, Mortgages, and Loans	3.1	out of	5

Raw Score Average for Machine-Scored Questions by Mathematical Understanding*

Procedural (P):	13.1	out of 21
Conceptual (C):	11.3	out of 18
Problem Solving (PS):	5.7	out of 10

*Refer to Appendix D of the 1998–99 *Mathematics 33 Information Bulletin,* for an explanation of mathematical understandings.

The means on written-response questions are lower than the means on machine-scored questions. The group of students achieving the standard of excellence (80% or higher, or A) on the whole examination had a mean of 86.6% on the machine-scored questions as compared with 78.0% on the written-response questions. The group of students achieving between 50% and 79% (B or C) on the whole examination scored a mean of 67.4% on the machine-scored questions, which is higher than the 52.7% they scored on the written-response questions. The group of students below the acceptable standard (49% or less, or F) on the whole examination had a mean of 42.7% on the machine-scored questions compared with 27.1% on the written-response questions. The strengths and weaknesses of student responses on the written-response questions are discussed later in this report. An analysis of these questions can be used to maximize student performance on future written-response questions.

Multiple-Choice and Numerical-Response Questions

Questions on the examination are organized into scenarios or practical situations that occur in real life. For the June 1998 Mathematics 33 Examination, personnel from the Northern Alberta Institute of Technology, Fairview College, Olds College, and Alberta Power (Forestburg) assisted teachers in the development of questions and scenarios. The multiple-choice, numerical-response, and written-response questions were mixed within each scenario of the examination, and where appropriate, questions from the same unit of the course were organized together.

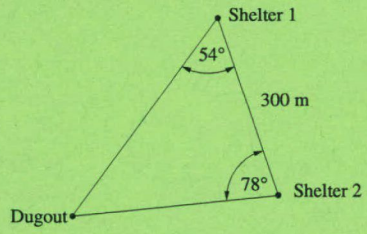
The machine-scored section of the examination requires mathematics students to demonstrate conceptual, procedural, and problem-solving understanding of the mathematical content of the course. During the marking session, markers agreed that these questions on the examination were fair, appropriate, and easy to read. Although it is difficult to fully assess problem-solving in machine-scored questions, students must use problem-solving strategies in order to solve a number of machine-scored questions. These problem-solving questions usually discriminate well between students who achieved the acceptable standard and students who achieved the standard of excellence. A table and discussion on how students performed on four of the ten questions requiring students to use problem-solving skills follow.

Percentage of Students Correctly Answering Machine-Scored Questions

	Question Number			
Student Group	**MC2**	**MC6**	**MC9**	**MC10**
All Students	69.3	63.2	58.4	64.5
Students achieving the *standard of excellence* (80% or higher, or A) on the whole examination	94.4	85.4	88.3	86.4
Students achieving the *acceptable standard* (between 50% and 79%, B or C) on the whole examination	75.7	69.6	63.1	70.7
Students who have not achieved the *acceptable standard* (49% or less, or F), on the whole examination	50.2	44.7	40.6	46.7

Use the following information to answer the next question.

The farmer analyzed the distances between a dugout and two shelters. The two shelters are located 300 m apart and form a triangle with the dugout, as shown below.



2. To the nearest metre, the distance between the dugout and the closer shelter is

A. 242 m

B. 293 m

***C.** 327 m

D. 395 m

For the problem-solving questions related to Trigonometry, students had to be able to analyze information from diagrams of oblique and right triangles and utilize their understanding of the interrelationships of sides and angles to formulate the steps needed to find the correct answer. For **multiple-choice question 2**, students had to find the shorter of two sides of an oblique triangle by determining the missing angle and then applying the sine law correctly. Almost 70% of all students successfully answered this question.

Students also had similar success in answering multiple-choice question 34, where, again, the missing angle and the correct sine law formulation had to be identified. In contrast, most students had great difficulty using appropriate problem-solving strategies to solve the multiple triangle question presented in numerical-response question 12. Markers recognized solving multiple triangle questions is an area for improvement.

Use the following information to answer the next question.

The researcher obtained four samples of plants from a barley field. The chart below indicates the number of weed plants in each of the four samples.

Sample Number	Number of Weed Plants	Sample Size (Number of Plants)
1	2	20
2	8	40
3	16	80
4	10	100

6. The sample size that would produce the **smallest** 90% confidence interval for the number of weed plants in the whole barley field is

A. 20
B. 40
C. 80
***D.** 100

Multiple-choice question 6 is classified as a Statistics unit question. It required students to find the confidence intervals for four samples of differing sizes (from tables in the data booklet) and then compare these intervals in order to determine the smallest one. This question was successfully answered, and it discriminated well between students achieving at the different standards shown in the table on page 4. The most common error made by students was to choose alternative A because this sample size had the smallest number of weed plants. This seems to indicate that these students have confused sample size with confidence interval.

Use the following information to answer the next question.

The farmer decided to use one acre of land for a rectangular garden. An acre is approximately 4 047 m^2. The rectangular shape that the farmer used was 25 m longer than it was wide.

9. It the width of the garden, in metres, is represented by x, then an equation that could be used to determine x is

A. $x^2 + 25x = 0$
B. $25x^2 + 5x = 0$
C. $x^2 + 25x + 4\,047 = 0$
***D.** $x^2 + 25x - 4\,047 = 0$

Students also were expected to use problem-solving strategies to answer two machine-scored questions pertaining to the Quadratic Functions and Equations unit. For **multiple-choice question 9**, students were reasonably successful in formulating the correct quadratic equation for a real-life problem. However, students had more difficulty in solving multiple-choice question 33. This question, relating to the parabolic flight path of an object and its representative function, required students to find a horizontal distance using their understanding of symmetry with respect to the vertex.

Use the following information to answer the next question.

From his income, the farmer's hired employee invests $3 500 per annum in an annuity that will mature in 12 years. Interest on the annuity is compounded annually. The company offering the annuity guarantees a return of $62 587.48.

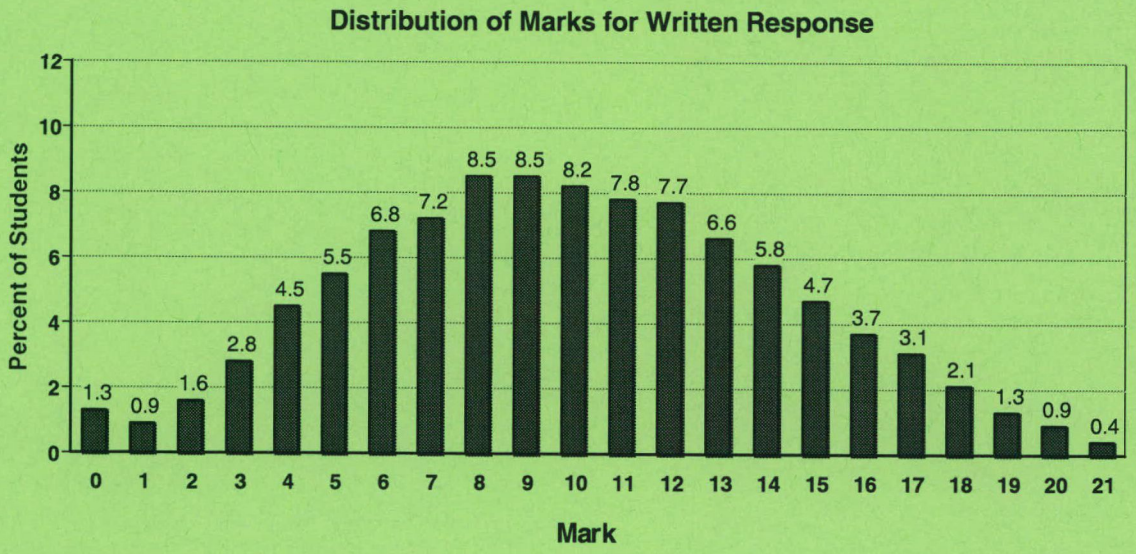
10. In order for this annuity to grow to $62 587.48, the annual rate of interest would be

A. 2%
***B.** 6%
C. 8%
D. 12%

Students were successful in answering **multiple-choice question 10**, a unique question requiring problem-solving understanding related to the Annuities, Mortgages, and Loans unit. This question required students to find the interest rate in the annuity tables by using some creative interpretation techniques. Routine questions expect students to find the periodic payment or total annuity, whereas questions involving problem-solving skills expect students to find the period, interest rate, or total interest.

Written-Response Questions

The graph below shows the percentage of students achieving various marks on the written-response questions. The maximum mark obtainable was 21. Questions in the written-response section dealt with four of the seven course units for Mathematics 33. Of the students who wrote the examination, 1.3% received no marks for the written-response questions, 44.1% received 11 marks or more (acceptable standard), and 7.8% received 17 marks or more (standard of excellence) out of 21.

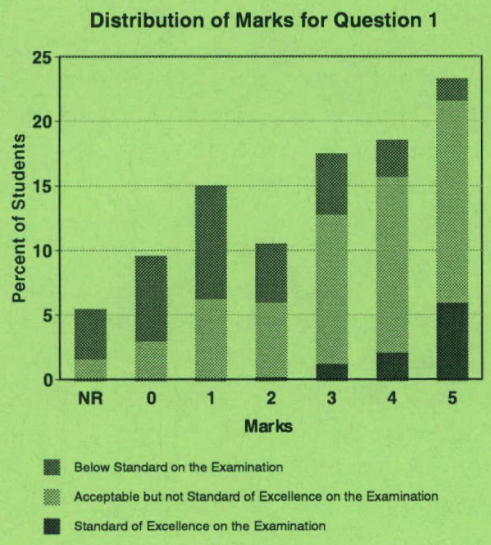


Below, the results of the written-response section of the Mathematics 33 Diploma Examination are tabulated according to the percentage of students from each group attaining the standards on each question.

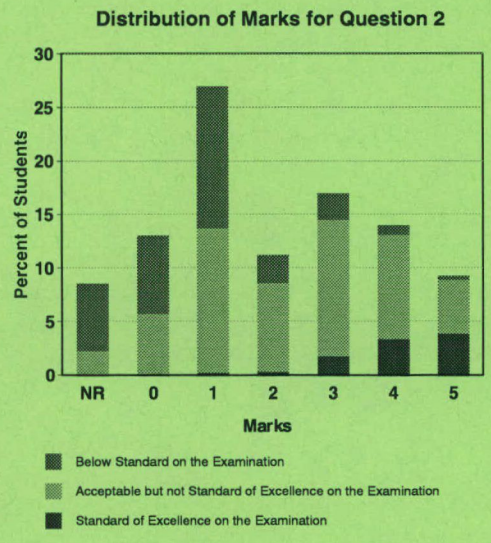
Percentage of Students Achieving the Standards on Written-Response Questions

	Question Number			
Student Group	**WR 1**	**WR 2**	**WR 3**	**WR 4**
Students at the *standard of excellence* (80% or higher, or A) who achieved 80% or higher on the question	81.7	73.1	59.0	72.7
Students at the *acceptable standard* (50% or higher, or A, B, or C) who achieved 50% or higher on the question	74.5	54.5	53.4	77.8

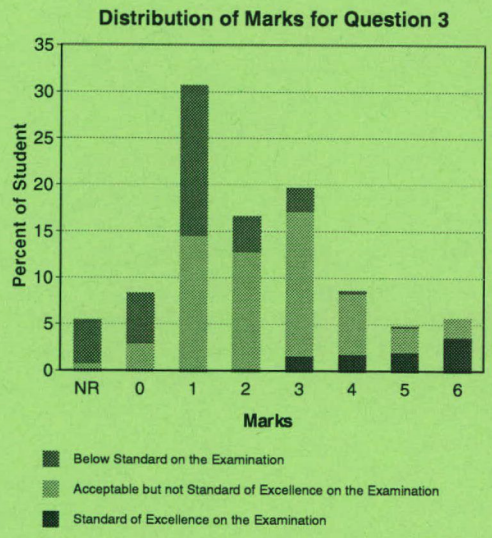
The written-response section is worth 30% of the total examination mark. Students are expected to use conceptual, procedural, and problem-solving understandings to solve the four written-response questions. Teachers can compare school and jurisdiction results with the provincial results presented in the graphs that follow to determine areas of strength and weakness in the achievement of their students and, consequently, areas of potential strength and weakness in their program.

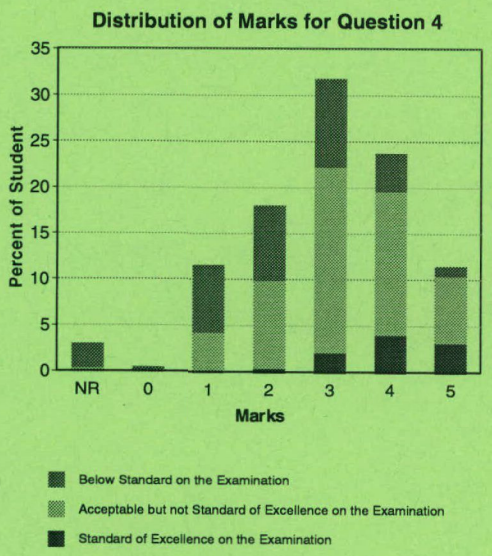


Question 1 required students to use loan and mortgage tables to calculate several values related to two borrowing options and to provide advantages and disadvantages for each of these options. The question was marked on a five-point holistic scale, and the average was 2.8 (55.9%). Teachers marking this question were impressed by students' well-written and clearly presented responses. Most students used the correct values from the tables in the data booklet, presented their steps in calculating amounts, and stated insightful reasons for and against the choice of the mortgage option. Markers were also pleased by the number of responses that included correct calculations of total amounts based on incorrectly calculated monthly payments. It was also noted that there were very few responses with rounding errors. However, teachers were concerned about the large number of "no responses" (5.5%), zeros (9.6%), and weaknesses related to communication and comprehension. Some students still used a compound interest formula instead of a table value to calculate the monthly payment, and, therefore, misinterpreted "total amount" to mean "total interest." A significant number of students used incorrect syntax (eg. $\frac{30000}{1000} = 30 \times 18.1499 = \$544.50$) and omitted dollar signs in their solutions. Instead of comparing values calculated in bullets 1 and 2 to justify their statements in bullet 3, some students incorrectly stated only the lower interest rate as the only advantage and the longer time period as the only disadvantage.



Question 2 required students to solve an applied trigonometry problem involving right triangles. The question was marked on a five-point holistic scale and the average was 2.03 (40.5%). Student responses demonstrated strengths in applying the tangent ratio or sine law and using appropriate problem-solving skills to determine the distances x and y. Markers agreed that no students should have had difficulty receiving one mark for finding the distance x (by subtracting several dimensions given on the diagram). However, of all the student responses, 21.6% (13.0% zeros and 8.6% "no responses") did not successfully perform this simple task, 27.0% received only one mark, and only 51.4% provided appropriate evidence of trigonometric application to receive 2 or more marks. Weaknesses in student responses were attributed to communication and conceptual errors. Many students did not reference their variables with the diagram or indiscriminately used the same variable (especially x, h, or y) to determine different unknown quantities. Several responses showed inappropriate rounding in intermediate steps or final answers, omitted units, failed to provide clear communication of the subtraction step in determining the distance y, misused equal signs (eg. $\tan 14° = \frac{o}{3} = 0.747$), or incorrectly found distance y by solving $\tan 22°$.





Question 3 required students to identify significant points on the graph of a quadratic function, explain how these points are used to derive the parameters of its equation in a particular form, and write an equation in expanded form. The question was marked on a six-point anaholistic scale, with one point allocated for the identification of an x-intercept and a five-point scale used for the determination of equations in different forms and the explanations associated with their derivation. The average for this question was 2.16 (35.9%). The markers felt that the strength of the responses included the identification of an x-intercept, writing the equation in its standard form $y = (x - 2)^2 - 9$, and referring the equation's parameters to the vertex. Markers also identified several major weaknesses in student responses. Justification for the value of k and explanations for how the point or points were related to the parameters of a derived equation were often weak or missing; as well, the expansion of an equation into the form $y = ax^2 + bx + c$ was incorrectly completed or simply omitted. In general, student responses lacked clear and logical communication. Markers also noticed that about 15% to 20% of the students misconstrued the instructions in bullet three to mean finding the slope.

Question 4 required students to interpret and analyze a graph based on a real-life scenario in terms of profit and loss and to justify a financial position based on this analysis. The question was marked on a five-point holistic scale, and the average was 2.95 (59.0%). Markers noticed that there were very few "no responses" (3%) and that almost all students provided complete responses for all parts of the question. Students successfully identified months when the business experienced a loss or "broke even," used dollar signs with graphical or calculated values, and provided reasonable explanations for parts c and d. Some of the weaknesses identified by markers were a lack of numerical data to support or justify answers (especially in part d), incorrect use of grammar and misspelled words, and the indication by some students that the words *data* and *justify* (a directing word) were not understood. Some students also incorrectly used values interpolated from the dotted line sections (between months) of the graph in their answers.

Markers also generalized that student performance on the written-response questions would be enhanced if students were engaged in various tasks and assessment instruments throughout the year that expected them to communicate their understanding of Mathematics 33 concepts and processes using correct terminology, logically presented and syntactically correct solutions, and complete sentences.

For further information, contact Ron Zukowski (rzukowski@edc.gov.ab.ca) or Corinne McCabe (cmcabe@edc.gov.ab.ca) at the Student Evaluation Branch at 427-0010. To call toll-free from outside of Edmonton, dial 310-0000.

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